A Review of the Family Caymanostellidae (Echinodermata: Asteroidea) with the Description of a New Species of *Caymanostella* Belyaev and a New Genus

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The history of the deep-sea asteroid family Caymanostellidae is reviewed. A recently proposed close relationship between *Caymanostella* and the concentricycloid genus *Xyloplax* is discussed and refuted. A new species in the genus *Caymanostella* is described from the Tasman Sea and a new genus, *Belyaevostella*, is described to accommodate the Indonesian species *C. hispida* Aziz and Jangoux. New observations for caymanostellid asteroids are the occurrence of papulae in the new genus, varied position of the gonopore associated with the proximal-most supcromarginals and internal structure of some abactinal plates.

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INTRODUCTION

The family Caymanostellidae was described by Belyaev (1974) to accommodate the then unique species *Caymanostella spinimarginata* Belyaev, collected from depths of 6740-6780m in the Cayman Trench and living on sunken wood. Belyaev included the family in the asterozoan order Phanerozonia because of the prominence of the marginal plates. He was uncertain whether the distinctive features including the shape of the oral plates, lack of ventro-lateral (actinal) plates, and the actinal spinulation represent primitive (plesiomorphic) features or derived (apomorphic) characters related to the specific habitat of the sea-stars. Consequently, he was also uncertain of relationships of the Caymanostellidae with other phanerozone families.

Later (1977) Belyaev and Litvinova described a second species, *C. admiranda*, which had been collected in 5220m from the northern part of the Coral Sea, West Pacific. They made no further comment on the relationships of the family.

Aziz and Jangoux (1984) have described a third species *C. hispida*, from 2350m in the Strait of Macassar (Indonesia), West Pacific. They suggest that because of the form of the abactinal and marginal skeleton, the family has closer affinities with members of the order Spinulosida, and in particular the family Asterinidae.

Smith (in Smith and Tranter, 1985) described a fossil sea-star, *Protremaster uniserialis*, from Sinemurian (Lower Jurassic) deposits on Alexander Island, Antarctica. He considered the species a tremasterin asterinid, but compared it, also, with *Caymanostella*. Rowe *et al.* (1988) and Rowe (1988), however, consider *Protremaster* to be an early caymanostellid asteroid, thus concluding that the family Caymanostellidae is of relatively ancient lineage and that early members possessed at least one row of actinal-lateral plates.

Blake (1987), in a major reclassification of post-paleaozoic asteroids, refers the Caymanostellidae to the order Velatida, which he re-established to include also the Korethrasteridae, Solasteridae, Myxasteridae and Pterasteridae. The Velatida are

included with the monofamilial Spinulosida within the superorder Spinulosacea. Blake (1987) contends that the Caymanostellidae are aberrant velatidans and that characters shared between *Caymanostella* and members of the Valvatida are '. . . best explained by convergence.' Unlike Aziz and Jangoux (1984), Blake (1987) does not draw a direct comparison with the Asterinidae, which latter family he had earlier (1981) transferred from the Spinulosida, (e.g. Spencer and Wright, 1966) to the Valvatida. Rowe *et al.* (1988) maintain the Caymanostellidae, Korethrasteridae and Asterinidae should be retained within the same order, the Valvatida. Rowe *et al.* (1988), in discussion of the origin of the Class Concentricycloidea, suggest that the caymanostellids and korethrasterids may warrant a supra-familial taxon of their own.

Smith (1988) classifies the Caymanostellidae as a sister group to *Xyloplax medusiformis* Baker, Rowe and Clark (1986) within the order Velatida (sensu Blake, 1987). He argues against the recognition of the Class Concentricycloidea erected by Baker *et al.* (1986) for *Xyloplax*.

In this paper, and following examination of over 250 specimens of caymanostellids, the family Caymanostellidae is comprehensively re-diagnosed and its relationships, including that with *Xyloplax* are discussed. A new species of *Caymanostella* is described and a new genus described for *C. hispida* Aziz and Jangoux. Two paratypes of *C. spinimarginata* Belyaev, one paratype of *C. admiranda* Belyaev and Litvinova and the holotype and paratype of *C. hispida* Aziz and Jangoux have been re-examined. In the text, Institution abbreviations are AM = Australian Museum; BM(NH) = British Museum of Natural History, London; NMNZ = National Museum of New Zealand, MNNH = National Museum of Natural History, Paris.

Systematic Account

Family CAYMANOSTELLIDAE Belyaev

Caymanostellidae Belyaev, 1974: 1502

Diagnosis (emended): Body pentagonal to circular in outline; aborally slightly convex, orally flat; body covered with thin or very thick epidermis; madreporite relatively simple; disc plate arrangement distinct or not, from arms, aborally; disc plates variously imbricated include centrodorsal, primary radial and interradial plates, a pair of distinctive distal-lateral disc plates (dldp) in each interradius and several intercalary plates; each dldp has an internal, horn-like process which abuts with its opposite number in the mid-interradial line, forming, with the oral plates, internal buttressing points between which a T-shaped odontophore is braced (Figs. 1, 5**F**); aboral arm plates imbricate proximally, comprising a carinal and one or more dorsal-lateral rows each side; aboral plates hexagonal, to fan-shaped, thin delicate and scale-like or thicker lenticulate and robust; superomarginals not conspicuous in fossil taxon but more or less rectangular conspicuous in Recent taxa, entirely abactinal, first pair usually markedly larger than succeeding ones, supermarginal plates either similar in size or smaller than inferomarginal plates; inferomarginals rectangular, delimiting margin of body at oral/aboral angle; terminal plates each with central perforation; actinal-lateral plates absent in Recent forms, present in known fossil taxon; adambulacral plates bar-like, extending between ambulacral and inferomarginal plates in Recent taxa; first adambulacral plate very short, second and third longest; furrow margin straight, furrow spines few (1-3); ambulacral grooves narrow or broad/petaloid; two rows of suckered tube-feet; 10 gonads, 1 pair to each interradius, visible from oral surface through thin, membranous, triangular 'window', actinal membrane with or without perforated plate spicules (Fig. 7); 10 gonopores one pair to each interradius, associated with proximalmost superomarginal plate of each plate series, as a marginal notch or piercing the plate, or

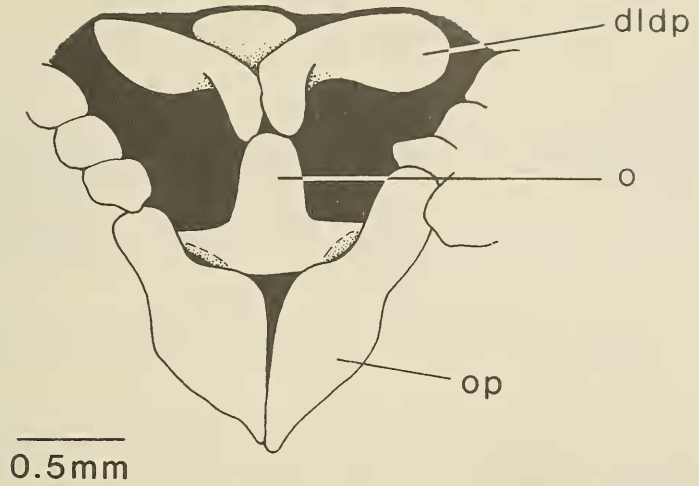

Fig. 1. Internal juxtaposition of horns of distal lateral disc plates (dldp), odontophore (o) and oral plate (op), viewed from oral surface.

positioned adjacent to first superomarginal plate (Fig. 2) (position of gonopores not determined in Fossil taxon); sexually dimorphic, male gonopores minute compared with size of female gonopores; abactinal plates bear granuliform or long, slender spinelets; adambulacral plates bear spike-like spinelets, inferomarginal plates bear 1-3 short, clavate or slender spines on their outer edge, forming an ambital fringe to the asteroid; no pedicellariae; papulae present or absent; habitat of Recent taxa sunken, waterlogged wood; Lower Jurassic — Recent.

Type genus: *Caymanostella* Belyaev, 1974 (own designation).

Other general included: *Protremaster* Smith, 1985; *Belyaevostella* gen. nov.

Remarks: The Caymanostellidae share with the Korethrasteridae Danielssen and Koren, 1884, the form of the adambulacral plates, the occurrence of an actinal membrane, though this latter is better developed in caymanostellids, and the absence of actinal-lateral plates in Recent taxa. Lack of fossil material of korethrasterids prevents comparison of early actinal morphology between the two families. Both families have taxa which possess abactinal papulae and taxa which do not. They differ, however, in shape, korethrasterids are stellate whereas caymanostellids pentagonal; abactinal plating, (3 of 4 genera of korethrasterids — *Peribolaster* Sladen, 1889, *Remaster* Perrier, 1894 and *Anareaster*, Fell and Clark, 1959) have cruciform plates; abactinal spination, korethrasterids have paxilliform plates whereas caymanostellids have an even covering of granuliform spinelets or spaced, elongate spinelets; and the more prominent development of marginal plates in caymanostellids.

Unless the form of the adambulacral plates and occurrence of an actinal membrane in both families can be shown to be the result of convergence, then they may be considered to be related, commonly derived and included within the same asteroid order. As far as the caymanostellids are concerned, the form of the Fossil *Protremaster* indicates Recent forms have lost actinal plates, though the adambulacral structure was already evolved in the Jurassic genus. There is no evidence to suggest that the bar-like adambulacral plates resulted from fusion with actinal-lateral plates. It can only be speculated that the extension of the adambulacral plates and loss of actinal-lateral plates is a response to specialized habitat/environmental pressures.

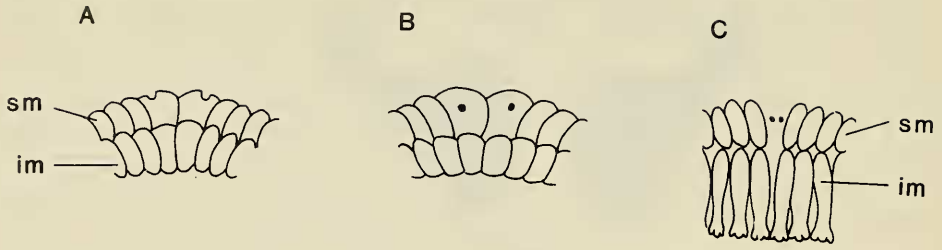

Fig 2. Position of gonopores in *Caymanostella* (**A** = marginal, **B** = piercing) and *Belyaevostella* (**C** = inter-proximal-most superomarginals).

Smith (1985) clearly saw in *Protremaster* close affinities with asterinid taxa rather than with *Caymanostella*. Paradoxically, therefore, there is a measure of agreement between Smith (1985) and Rowe *et al.* (1988) regarding the relationship of caymanostellids and asterinids when Smith concludes *Caymanostella* may be a specialized offshoot from tremasterins. I would support this proposition in referring to the possible derivation of caymanostellids from asterinids since I am unconvinced of the subfamilial relationship of tremasterins within the family Asterinidae (Rowe and Berents in prep.) and Smith's genus is not a tremasterin in any case. This view places the families Caymanostellidae and Korethrasteridae with the Asterinidae in the order Valvatida under Blake's recent reclassification. Whether a separate supra-familial taxon is warranted (Rowe, 1988) for this group of families, remains to be determined.

However, I would contend that Smith's (1988) comparison of *Caymanostella* and *Xyloplax* contains errors of interpretation due to his reliance on inadequately detailed published data and lack of examination of relevant specimens. Full descriptions of *Xyloplax* spp., including sperm development and morphology, are now available (Rowe *et al.*, 1988; Rowe, 1988; Healy *et al.*, 1988). The Caymanostellidae are detailed herein. It can now be shown that a number of characters chosen by Smith (1988), to show a close relationship between *Caymanostella* and *Xyloplax*, are incorrect (see Table 1). I would also point out that caymanostellids reach a diameter of at least 27mm (R = 13.6mm in *Belyaevostella hispida*), three times the 9mm recorded by Smith (1988: 20).

There can be, in my view, no support for a progenetic origin for *Xyloplax* (Smith 1988: 20) based on the early form of the asteroid water vascular system. Smith contends that in metamorphosing asteroids, before arm and ambulacral skeletal development '. . . the first few tube feet in effect form a peripheral circle.' In my view, this would be due to the juxtaposition of a small, primary (terminal) tube-foot adjacent to which, and on either side, are one or two larger ambulacral tube feet developing along a primordial radial canal. There is no evidence of an incipient double-ring arrangement as evolved in *Xyloplax*. Such an arrangement, if it occurred, would have profound implications in the development of the radial structure of the ambulacral water vascular system in adult echinoderms. There is no embryological evidence that such is the case in asteroids or any other echinoderms.

Contrary to Smith's (1988) reliance on the superiority of his cladistic approach to the relationship between *Caymanostella* and *Xyloplax*, I do not believe that his use of cladistics has increased the objectivity of approach to this particular problem. In my view the relationship between *Caymanostella* and *Xyloplax* remains as remote as that described by Baker *et al.*, 1986; Rowe *et al.*, 1988; Rowe, 1988 and Healy *et al.*, 1988.

TABLE 1

Comments on characters chosen by Smith (1988) in cladistic analysis

Character chosen by Smith (1988)	Comments
1. Calcinal ring	Inappropriate for use above generic if not species level.
2. Superomarginals	Palaeontological evidence does not support Smith's use of this character in such a narrow sense.
3. Hyaline spines	Highly derived; presence or absence of these specialized spines is too widespread in the Asteroidea for use to compare the Concentricycloidea. In any case they are absent in both caymanostellids and xyloplacids.
4. Ambulacrals	Interpretation is critical. Rowe *et al.*, (1988) and Rowe (1988) interpret ambulacrals of *Xyloplax* as having fused with the adambulacral/oral plate to form the expanded oral frame.
5. Oral plates	Interpretation is critical. The oral plates are not unusual in the asteroid *Caymanostella*, but substantially altered in *Xyloplax*, forming, with fusion to ambulacral plates a uniquely widened oral frame (Rowe *et al.*, (1988); Rowe (1988)).
6./14. Adambulacral arrangement	In caymanostellids the adambulacrals, except the first one, have extended in width across the actinal surface. The first adambulacral is NOT reduced to rudimentary state as claimed by Smith (1988: 20). The adambulacrals are NOT lost from *Xyloplax* but have changed roles to act as 'ambulacral' plates. Articulation between the adambulacrals and the ambulacral/oral frame ossicles is substantially altered (see Rowe *et al.*, 1988).
7. Actinals	These are present in caymanostellids, even if only in the fossil taxon, *Protremaster*, described by Smith (1985).
8. Terminal plates	Perforated terminal plates occur across a diverse range of taxa (Rowe, 1985) including Caymanostellids, but not *Xyloplax*.
9. Inferomarginals	These are differentiated in each of the groups included in Smith's (1988) cladogram.
10. Peristome/oral plates	The oral frame of *Xyloplax* comprises a ring of ossicles formed by fusion of adambulacral oral/ambulacral plates.
11. Madreporite	Caymanostellids have a small but typical madreporite.
12. Abactinal plates/ papulae	One caymanostellid (described herein) DOES possess papulae; the type genus of the korethrasterids, *Korethraster*, does NOT possess papulae; plates are imbricate, not tessellate; caymanostellids bear granuliform and spiniform abactinal armament on plates.
13. Tube-feet	Caymanostellids possess suckered tube-feet NOT pointed tube-feet. This was a mistake made by Belyaev (1974) and perpetuated by Smith (1988) clearly without reference to any specimens. The pointed tube-feet of *Xyloplax* are explained by Rowe (1988) to be probably functionally associated with living in a soft substrate.
14.	See 6.
15. Ambulacral plating	A critical difference in interpretation by Rowe *et al.* (1988) and Rowe (1988) who consider the perradial plates between which the tube-feet protrude to be modified adambulacrals.

Genus *Caymanostella* Belyaev

Caymanostella Belyaev, 1974: 1502

Diagnosis (emended): Caymanostellid sea-stars with hexagonal to fan-shaped, lenticulate abactinal plates; thin epidermis not obscuring skeletal plates (in adults); granuliform abactinal armament; ambital spinelets club-shaped; gonopores form a notch in aboral edge of plate (Fig. 2**A**) or pierce the first superomarginal plates (Fig. 2**B**); spicules absent from actinal membrane; papulae absent, distributed in the Caribbean and West Pacific.

Type species: *C. spinimarginata* Belyaev, 1974, by own designation.

Other species included: *C. admiranda* Belyaev and Litvinova, 1977; *C. phorcynis* sp. nov.

Remarks: *Caymanostella* is distinguished from *Belyaevostella* gen. nov., the latter genus possesses delicate, scale-like abactinal plates embedded in a thick epidermis (in adults), spiniform abactinal and marginal armament, abactinal papulae and spicules in the actinal membrane. The gonopores of *Belyaevostella* occur adjacent to but do not pierce or notch the superomarginal plates.

Caymanostella spinimarginata Belyaev
Figs 2**A**, 3**A-B**

Caymanostella spinimarginata Belyaev, 1974: 1504, figs 1-2.

Material examined: 2 specimens (paratypes, BM(NH) 1987.3.26.1 (R = 4.8mm) and 1987.3.26.2 (R = 4.3mm)), 19°38.5′N, 76°37.5′W, 6740–6780m (Oriente depression, eastern part of Cayman Trench, Stn 1267), R/V 'Akademik Kurchatov', 25.3.73.
Diagnosis: A species of *Caymanostella* in which the abactinal plates imbricate in a similar direction, only the primary interradial plates (including the madreporite) are distinguishable on the disc; there are at least two alternating, dorsal-lateral rows of plates either side of the carinal row along each of the arms; the supero- and inferomarginal plates are of similar size to each other; the gonopore is positioned in a notch on the upper margin of the proximal-most superomarginal plate in each series; the oral plates each with 3 oral, and a single suboral, coarsely thorned spines; adambulacral plates with a single furrow and up 10 coarsely thorned spines, these latter mostly in two alternating rows along the actinal surface of the plate; outer edge of inferomarginals each with 2 elongate, club-shaped spines, actinal membrane triangular to heart-shaped; abactinal granulation homogenous, blunt, club-shaped; maximum known size for species R = 4.8mm; distribution, Cayman Trench.
Remarks: The marginal position of the gonopore on the proximal-most superomarginal plates immediately separates this species from *C. admiranda* Belyaev and Litvinova and *C. phorcynis* sp. nov. Differences in abactinal plate arrangement also separate the species.

Caymanostella admiranda Belyaev and Litvinova
Fig. 4**A-B**

Caymanostella admiranda Belyaev and Litvinova, 1977: 1983, figs 1 and 2.

Material examined: 1 specimen (paratype, BM(NH) No. 1987.3.26.3 R = 3.4mm) 7°31.1′*S*, *149*°51.1′E, (Coral Sea), 5220m, R.V. 'Dm Mendeleev' (Stn. 1234), 15.12.75; 2 specimens (Amsterdam Museum, R = 4mm; R = 2.1mm) 10°39′S, 123°40′E (off Timor) 520m, (soft grey mud with brown upper layer), 'Siboga' Expedition, (Stn. 297).
Diagnosis: A species of *Caymanostella* in which the abactinal plates imbricate and are arranged in two distinct fields; on the disc the centrodorsal plate is surrounded by an inner ring of 7 plates, 5 large trapezoidal radial plates and, in each of 2 of the interradii, a small squarish plate, there is an outer ring of 10 plates, 5 large, hex-heptagonal interradial plates and 5 smaller hexagonal, rather shield-shaped radial plates; between the primary interradial plate and radial plate on the outer ring of the disc plates, and the proximal carinal plate and dorsal-lateral plate is an obliquely directed, oblong distal-lateral disc plate; along the arms are 3 heptagonal-fan-shaped carinal plates, with 2-3 dorsal-lateral plates alternating either side; the terminal plate is radially longer than wide, with a relatively small perforation towards its distal edge; there are 6-7, more or less equal-sized superomarginal and inferomarginal plates, with the exception that the proximal-most superomarginal in each series is about twice as broad as its immediate neighbour, a small, wedge-shaped plate separates the upper half of the proximal-most two superomarginals across the mid-interradial line: a small gonopore (male) pierces the centre of each of the first superomarginal plates; the oral plates each bear 2 oral and

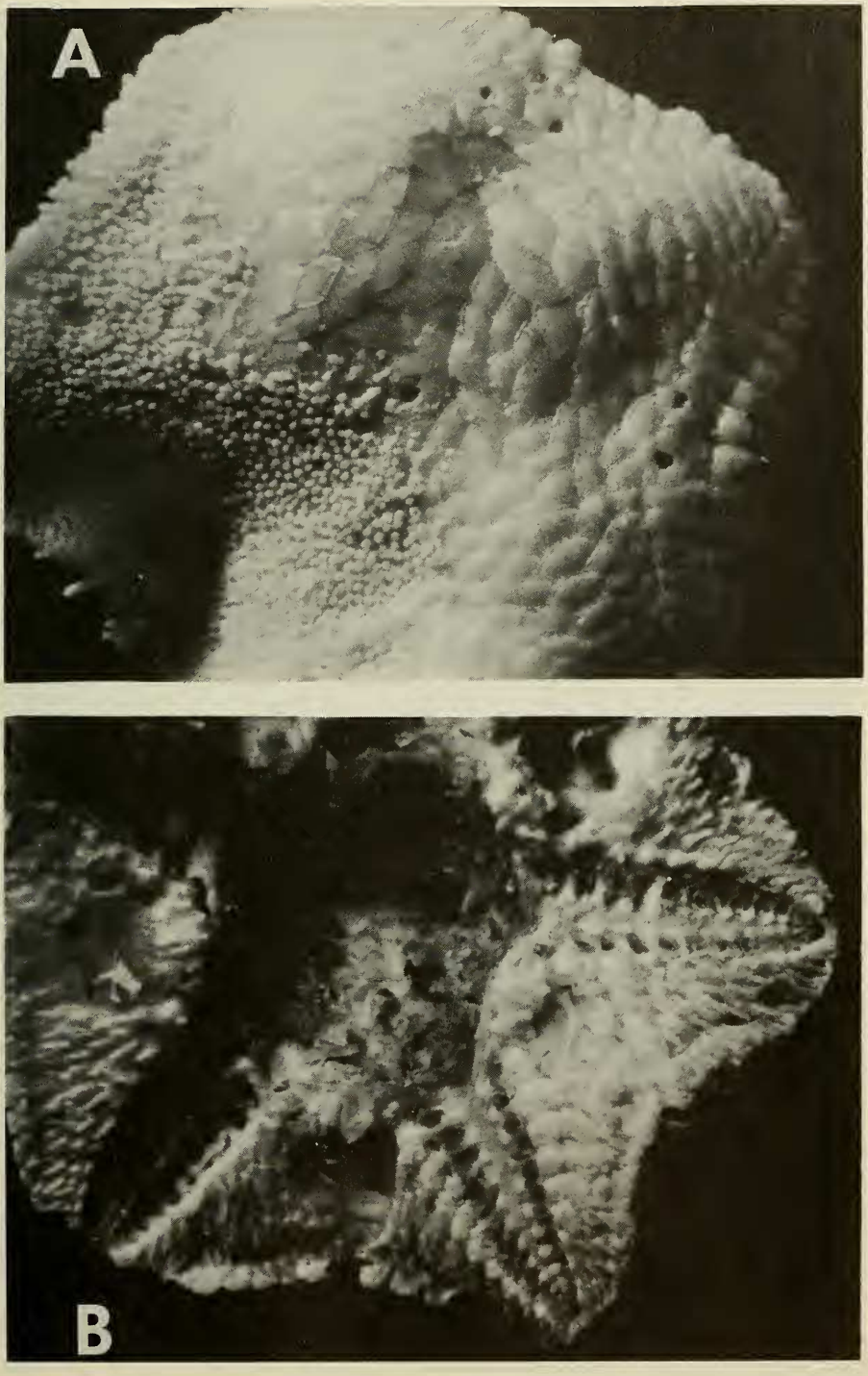

Fig. 3. Caymanostella spinimarginata Belyaev (paratype, BM(NH) 1987.3.26.1). **A** = aboral view, **B** = oral view (R = 4.8mm).

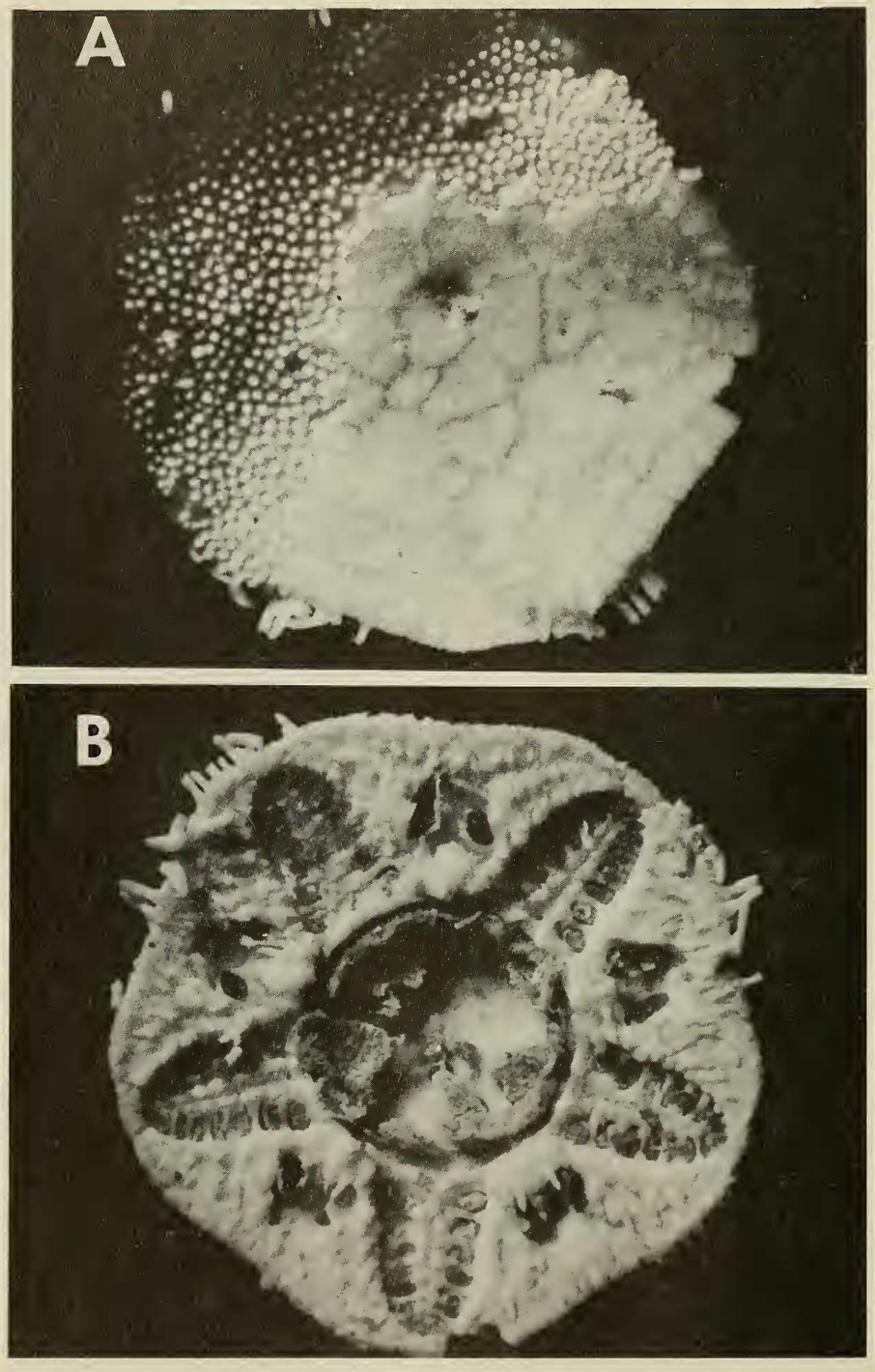

Fig. 4. Caymanostella admiranda Belyaev and Litvinova (paratype, BM(NH) 1987.3.26.3). **A** = aboral view, **B** = oral view (R = 3.4mm).

one suboral, rather coarsely thorned spines; adambulacral plates bear a single furrow spine and only one or two coarsely thorned spines on the actinal surface of the plate; the outer edge of the inferomarginal plates bear 2 marginal spines; the actinal membrane is heart-shaped; furrows are petaloid with up to 8 pairs of tube-feet; abactinal granulation even, over abactinal surface, granules low, rounded, 2 sizes more or less apparent; maximum known size, R = 4.90mm; distribution Coral and Timor Seas.

Remarks: Belyaev and Litvinova (1977) neither described nor adequately figured the abactinal plate arrangement for their species. The diagnosis, therefore, includes information based on one of the two paratype specimens which has been donated to the British Museum (Natural History) in London by Dr. G. Belyaev. Both of the 'Siboga' specimens (R = 4mm, r = 3.3mm, R/r = 1.2mm; R = 2.1mm, r = 1.8mm, R/r = 1.16) are in very poor condition, broken, and have apparently dried out at some time prior to this examination. The specimens are currently stored in alcohol, but dissociation of some plates indicate probable original storage in formaldehyde solution. Because of the fragility of the specimens, the abactinal granules have not been removed to examine the plate arrangement. However, where granules have already been lost, it is evident that the hex-heptagonal shape of the plates and abactinal plate arrangement is similar to that described for *C. admiranda*. This second record for *C. admiranda* therefore requires confirmation when better preserved material becomes available from the Timor Sea, particularly considering the shallow depth from which the specimens were collected.

The shape and arrangement of the abactinal plates clearly identifies *C. admiranda* from its congener *C. phorcynis* sp. nov., with which it shares the feature of the gonopores piercing the superomarginal plates. Currently, the geographical range of *C. admiranda* is considered to extend between the Coral and Timor Seas in depths of 5220m and 520m respectively.

Caymanostella phorcynis sp. nov.
Figs. 2**B**, 5**A-D**

Material examined: 3 specimens (holotype, AM J18911, 2 paratypes, (1 dissected for SEM) AM J17880) 34°54′S, 151°14′E to 34°50′S, 151°15′E, 993-1030m (off Shoalhaven Bight, New South Wales, Australia). N.S.W. State Fisheries R/V 'Kapala', 26.10.83; 3 specimens (paratypes, AM J18910 (1), AM J17830 (2)) 35°31′S, 150°50′E to 35°28′S, 150°53′E, 938-994m (off Shoalhaven Bight, New South Wales, Australia), N.S.W. State Fisheries R/V 'Kapala', 8.9.83; 2 specimens (paratypes, AM J16365) 33°40′S, 151°56′E to 33°37′S, 151°56′E, 736m (off Broken Bay, New South Wales, Australia), N.S.W. State Fisheries R/V 'Kapala', 6.12.77; 9 specimens (paratypes NMNZ 4248(5), AM J18912(2), AM J18913(2), 37°23.7′S, 177°39.5′E to 37°23.7′S, 177°36.6′E, 1075-1100m (off White Is. north island of New Zealand), USSR f/v 'Kalinovo', on/in large waterlogged log of *Coriaria arboraea*. 3 specimens (paratypes, NMNZ 4252) 42°47.1′-42°48.2°S, 175°45.6-175°47.2°W, 1174-1180m, (NE of Chatham Islands), F.V. 'Otago Buccaneer', 22.7.84, on wood; 230+ specimens (NMNZ 4247), 37°23.7′S, 177°39.5′E to 37°23.7′S, 177°36.6°E, 1075-1100m (off White Is, north island of New Zealand), USSR f/v 'Kalinovo', on/in large waterlogged log of *Coriaria arborea*; 7 specimens (Amsterdam Museum) 3°27.1′N, 125°18.7′E, 2053m, fond dur, traces de sable fin, foncé et dur, 'Siboga' Expedition (Stn. 126).

Diagnosis: A species of *Caymanostella* with fan-shaped plates; gonopores piercing the proximal-most superomarginal plates; 8-15 supero- and inferomarginal plates similar in size (except larger proximal-most superomarginals); ambulacral furrows narrow;

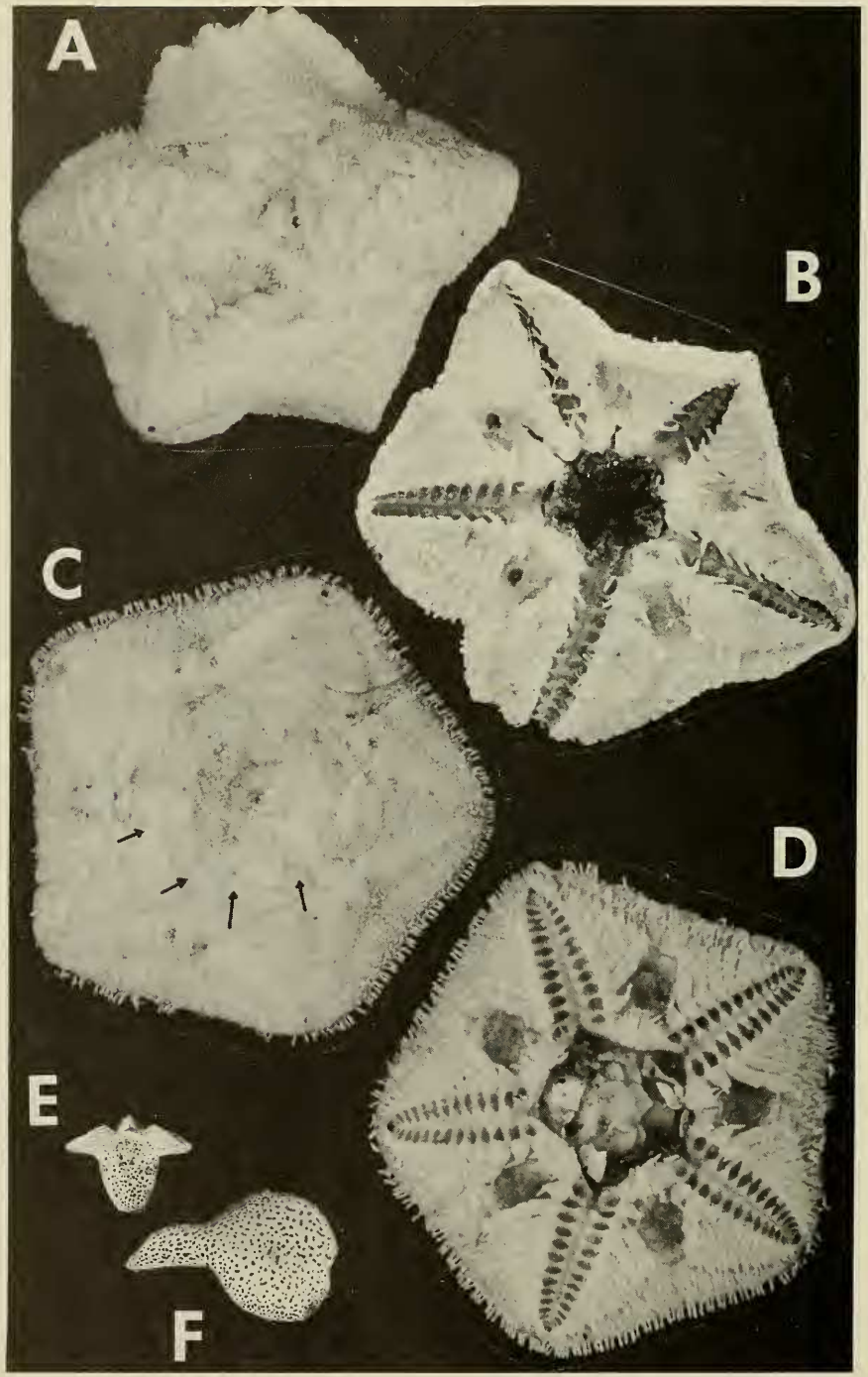

Fig. 5. Caymanostella phorcynis sp. nov. (holotype, AMJ 18911) **A** = aboral view, **B** = oral view (R = 5.0mm). (Paratype, NMNZ 4248), **C** = aboral view (arrows indicate positions of distal-lateral disc plates), **D** = oral view (R = 5.0mm), **E** = distal-lateral disc plate (x 22), **F** = odontophore (x 22).

adambulacral plates with 1-2 furrow spines, 10-12 spines on the actinal surface; abactinal granulation even, granules dome-shaped.

Description: The specimens range in size from R = 2.8–10.5mm, r = 2.2–8.5mm, R/r = 1.05–1.30 (holotype: R = 5.0mm, r = 3.9, R/r = 1.28). The abactinal surface is covered with imbricating plates almost all of which imbricate in a similar direction, with the proximal edge of each plate overlying the distal edge of the preceding plate (Fig. 5**A**, **C**). On the disc imbrication is less regular. However, the only plates which can be most easily distinguished are the 5 primary interradials by virtue of their larger size than the surrounding plates and by the location of the madreporite in interradius CD. Also recognizable is a fan-shaped plate distal to the primary interradial plate and between it and the proximal-most two superomarginals. A small distal-lateral disc plate is separated either side of the overlap between the primary interradial plate and the more distal fan-shaped plate described above (Fig. 5**C**, **E**). An additional series of 3 small plates separates the dldp and interradial fan-shaped plate from the primary interradial in the large specimens. The anus is surrounded by 4-5 plates.

Along the arms is a carinal row of 5-8 fan-shaped plates, either side of which is a row of 3-6 dorsal-lateral plates (Fig. 5**A**, **C**). These latter plates alternate with the carinal plates. Occasionally, on some arms, 2 or 3 small intercalary plates are present, which disturbs the regularity of the dorsal arm plate arrangement. In the largest specimen (NMNZ 4252; R = 10.5mm) 3 plates form a second dorso-lateral series, alternating with the plates of each of the first series. The terminal plate bears a large, more or less central perforation.

There are 8-15 superomarginal and inferomarginal plates which are elongate at right angles to the periphery. These plates decrease in size regularly towards the arm tips. The first superomarginal on adjacent arms is about twice as large as the next adjacent plate. It bears, towards its centre, a gonopore. The other marginal plates are of similar size to each other along the length of the arms. The edge of each of the inferomarginals bears two spines.

The furrows are narrow, or at the most in smaller specimens, sub-petaloid (Fig. 5**B**, **D**). There are 9-14 pairs of well-developed tube-feet in each ambulacrum, the number increasing with growth. The ambulacral plates are dumb-bell-shaped.

With the exeption of the first plate, the adambulacrals are typically elongate, obliquely perpendicular to the groove, extending to the proximal edge of the inferomarginal plates. These plates decrease in size towards the arm tip. The adambulacral plates bear rugose, tapering spines. The first plate bears 3-5 spines, of which the innermost 2, occurring slightly obliquely on the adradial edge are interpreted as furrow spines. Up to 10-12 spines occur on each of the remaining adambulacral plates of which 2 furrow spines occur regularly on the adradial edge of the first 4 plates and irregularly alternating with 1 furrow spine to the seventh plate, thereafter 1 furrow spine occurs on the adradial edge of each of the adambulacral plates. The remaining spines are in two alternating rows across each plate. The lower surface of each inferomarginal plate bears spinelets similar in form to, but smaller than, those on the adambulacral plates (Fig. 5**B**, **D**).

The oral plates bear 3-4 furrow spines, 5 on the largest specimen (NMNZ 4252; R = 10.5mm) and 2-3 suboral spines.

The gonads on either side of the interradial membrane, can be seen through a more or less triangular actinal membrane. This membrane is delimited by the oral plates, the first 2 adambulacral plates and the innermost 2 inferomarginal plates.

The actinosome is large, about ⅓ diameter of the preserved animals.

Abactinal granulation is fine, even, with granules slightly longer than broad, dome-shaped, slightly spaced, 9-12 per mm.

Both the anus and gonopores are surrounded by 7-9 granules.

Etymology: *Phorcynis*, daughter of the sea god *Phorcus* and *Medusa*.

Remarks: The shape and arrangement of abactinal plating easily separates *C. phorcynis* from *C. admiranda* Belyaev and Litvinova, which otherwise share the feature of the gonopore piercing the proximal-most superomarginal plates.

Although they do not appear to differ significantly from Tasman Sea specimens, the seven 'Siboga' specimens are identified as *C. phorcynis* with some hesitation due to their very poor state of preservation. Further material in better preserved state is required to confirm the occurrence of *C. phorcynis* in the Indonesian region. Otherwise *C. phorcynis* is known from both sides of the Tasman Sea in depths between 736-1208m. The 'Siboga' specimens were taken in deeper water at a depth of 2053m.

Belyaevostella gen. nov.

Description: A caymanostellid sea-star with body becoming invested in thick skin with growth which includes, aborally, very thin, finely perforated, scale-like abactinal plates, irregularly imbricating and in no apparent order; superomarginal plates squarish in juvenile specimens, becoming elongate in adults but smaller than the elongated inferomarginals; proximal-most and interradially adjacent superomarginals abut in juveniles, becoming divergent in large adults (Fig. 1**C**); gonopores open between the diverging, proximal-most superomarginals (Fig. 1**C**); aboral papulae present; actinal membrane with perforated plate-like spicules (Fig. 7**A**, **B**); adambulacral and oral plates as for family; distributed in East Indian region and off NE coast of Australia in depths of 1301-1350m; habitat sunken, waterlogged wood.

Type species: *Caymanostella hispida* Aziz and Jangoux, 1984, by designation.

Other species included: None.

Etymology: Named for Dr. G. Belyaev who described the family. Gender feminine.

Remarks: The form and arrangement of the skeleton on the oral surface clearly shows this genus to be a member of the family Caymanostellidae. However, the form and arrangement of the abactinal plates, position of the gonopores, presence of spicules in the actinal membrane and more particularly the presence of abactinal papulae, all distinguish *Belyaevostella* from *Caymanostella* at generic level.

Belyaevostella hispida (Aziz and Jangoux)
Figs. 2**C**, 6**A-B**, 7**A-B**

Caymanostella hispida Aziz and Jangoux, 1984; 190, pl. 3.

Material examined: 2 specimens (holotype MNHN, ECAS 10056; paratype MNHN, ECAS 10057), Station 220 (0°13.79′S, 188°12.73′E), 2350m, Macassar Strait, Expedition franco-indonésienne 'Corindon.' 1 specimen (Amsterdam Museum), Station 88 (0°34.6′N, 119°8.5′E), 1301m, Macassar Strait, 'Siboga' Expedition. 1 specimen (Australian Museum J21783), Station 16 (11°41.55′S, 145°36.65′E), 2006-2053m, off NE coast (Queensland) of Australia, collected from log, 'Franklin' Cruise.

Diagnosis (emended): as for genus; additionally inferomarginal plates with 3-4 elongate, acutely tipped spinelets along their margin in smaller specimens (R = <8mm) (not observed in largest specimen, R = 13.6mm); adambulacral plates with 3-5 spines forming a simple transverse row across the plates; oral plates with 3 (not 2; Aziz and Jangoux, 1984) furrow spines and a single suboral spine.

Remarks: The investment of the body in a thick skin, the presence of aboral papulae and the occurrence of spicules in the actinal membrane are all new observations for this species. The holotype (R = 8mm) and paratype (unmeasurable) are dried specimens which are in generally poor condition. It is not surprising, therefore that the papulae

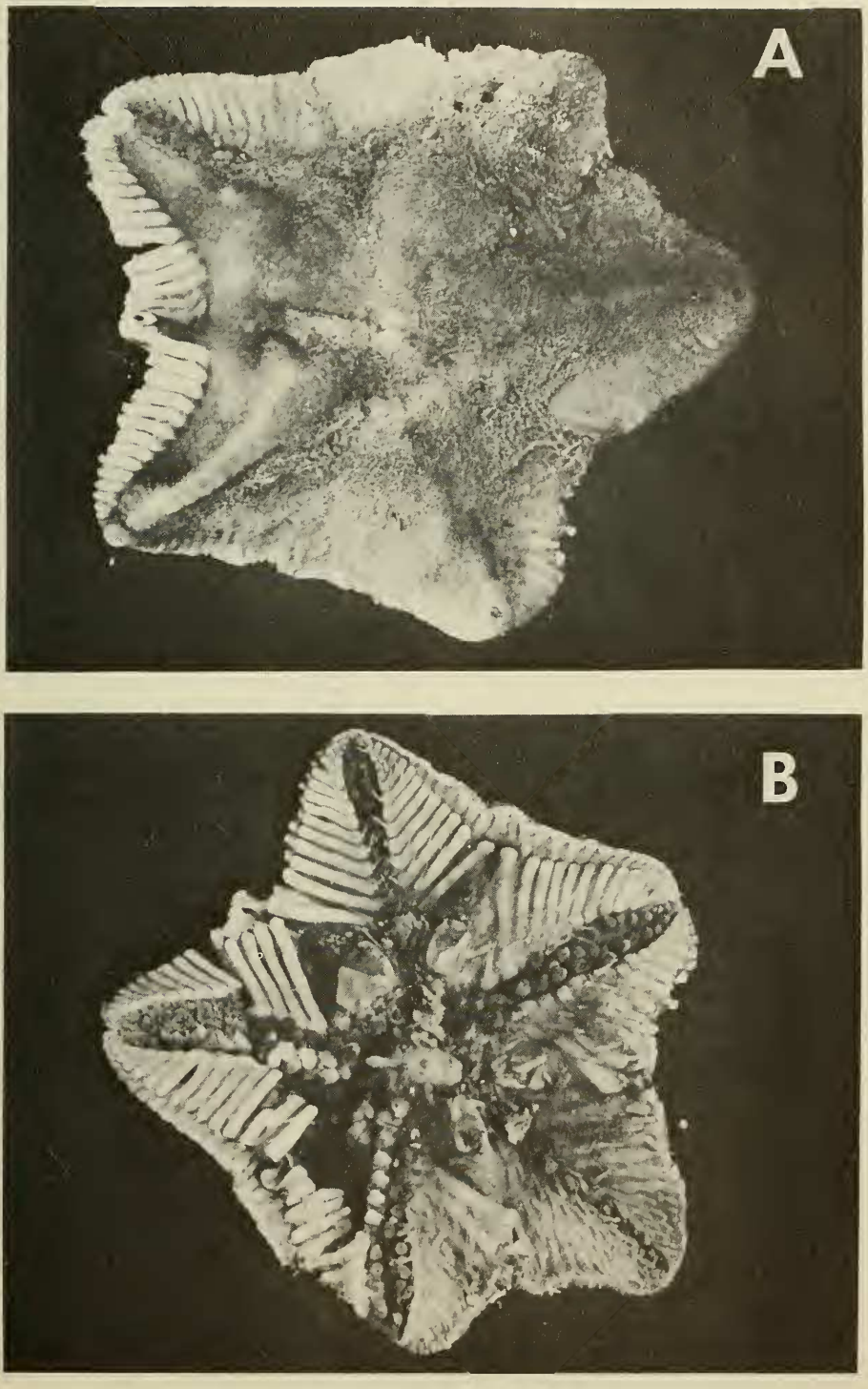

Fig. 6. Belyaevostella hispida (Aziz and Jangoux) (AMJ 21783) **A** = aboral view, **B** = oral view (R = 13.6mm).

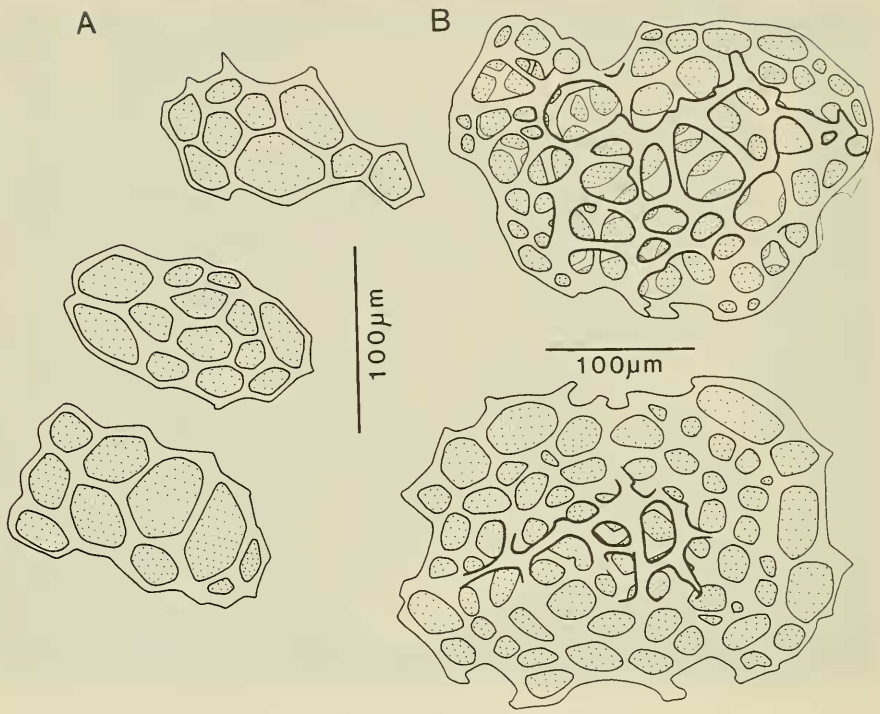

Fig 7. Spicules from actinal membrane of *Belyaevostella hispida*. **A** = specimen R = ?<8mm (paratype, MNHN ECAS 10057), **B** = specimen R = 13.6mm (AMJ21783).

were not observed by Aziz and Jangoux (1984). Also the skin investing the body is thin and not readily apparent. However, I was able to find relatively simple spicules (Fig. 7**A**) in the actinal membrane of these specimens. A third specimen, from the Macassar Strait (Siboga Expedition) is smaller than the type specimens (R = 5.3, r = 4.5, R/r = 1.17). Although now stored in alcohol it is apparent the specimen has been dried at some point during its storage. It therefore does not have thick investing skin cover. It does appear to me that the investing skin develops with growth of the animal. A further growth feature appears to be the change in shape of the interradially adjacent pair of superomarginal plates. In the smallest (Macassar) specimen these plates are squarish and distinctly smaller than the first pair of inferomarginal plates. However, in the type specimens the shape of these superomarginals is already changing to becoming elongate. In the largest specimen, which I do not hesitate to identify with the type specimens, despite a much larger size, these superomarginals are as slender as the first pair of inferomarginal plates, though still only about half as long. Curiously, also the two superomarginals diverge from each other and away from the mid-interradial line. Dissection from the ventral surface shows the gonoducts to lie in the space between the divergent superomarginals so that the gonopores do not either notch or pierce the adjacent marginal plates.

This distinctive caymanostellid genus interestingly shows a convergent possession of papulae with the genera *Peribolaster* Sladen, 1889, *Remaster* Perrier, 1894 and *Anareaster* Fell and Clark, 1959 in the closely related family Korethrasteridae, but without the development of cruciform and paxilliform abactinal plates.

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